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POTENTIAL DAMAGE TO FOREST TREE SEED DURING PROCESSING, PROTECTIVE TREATMENT, AND DISSEMINATION[1/]

by

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Abstract

Seed is susceptible to damage each time it is handled. Damage may be inflicted during various steps in processing, treatment with chemicals, or dissemination by seeding devices. There is evidence that seed damage is cumulative. Thus, each new bump or treatment may bring the seed closer to death. Some present practices cause damage to seed, but the contribution to impaired germination from each possible source of damage is not known. Research is needed to develop the best possible methods for processing, treating, and disseminating valuable tree seed.

Dissemination of seed by most western forest trees is aided by a seed wing which also serves as a parachute to insure the seed a soft landing. This is Nature's way--painless seed extraction; floating, gliding seed dissemination. Forests have regenerated this way for

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1/ From a speech presented at the Tree Seed and Reforestation Seminar for Southwest Oregon, sponsored jointly by the Siskiyou Chapter, Society of American Foresters, and Southern Oregon College, October 19-20, 1967, Ashland, Oreg.

centuries. Then along comes the forester. Nature's way is too slow for him. So he picks cones--frequently before they are ripe--roughly extracts the seeds, and forcibly removes Mother Nature's seed parachute. Later, he coats the seeds with toxic chemicals and blasts them out over the forest through seeding devices which are anything but gentle.

Seed is susceptible to damage each time it is handled. Because seed damage is cumulative, each new bump brings the seed closer to death, whether the bump comes from processing or dissemination, and whether the seedcoat is broken or unbroken. Protective chemicals, which may enter through the cracks or breaks or be imbibed by the intact seedcoat, must also be considered potential contributors to poor seed performance.

First, let's look at data from Dr. George Allen's studies[2/] in British Columbia on physical damage to seed--how it may be caused and how it affects germination. Then, we'll consider information from a study on helicopter seeding devices conducted by the Pacific Northwest Region, Forest Service, U.S. Department of Agriculture. Next, we will take up chemicals and coatings, drawing information from the literature and from a small laboratory test made at the Pacific Northwest Forest and Range Experiment Station. Finally, we will dwell upon the interrelated effects of physical and chemical damage. Looking back on it all, I believe you will be struck by the inadequacy of our knowledge and the need for more research on seed.

Physical Damage to Seed

Some of Dr. Allen's tests show how commercial processing of cones and seeds may reduce germination percent of Douglas-fir. In one study, replicated samples were taken (1) from the hopper before processing started, (2) from different places in the seed bin under the tumbler, (3) after different lengths of time in the dewinger, and (4) following passage through the cleaner (fig. 1). Seeds taken from the first quarter, second quarter, and last half of the seed collection bin were designated grade 1, 2, 3, respectively. These grades represent increasing lengths of time seed was in the tumbler. The respective grades were processed through the dewinger and the cleaner. Seed which left the hopper with a germination capacity of 94.5 percent came out of the cleaner averaging 63.3 percent. Seed which fell from the tumbler early suffered least, even if subjected afterward to 30 minutes in the dewinger. Even so, the smallest difference from start to finish exceeded 12 percent. This is too great a loss to accept if avoidable.

[2/] Allen, G. S. Factors affecting the viability and germination behavior of coniferous seed. Forest. Chron. 34: 266-298, illus. 1958.

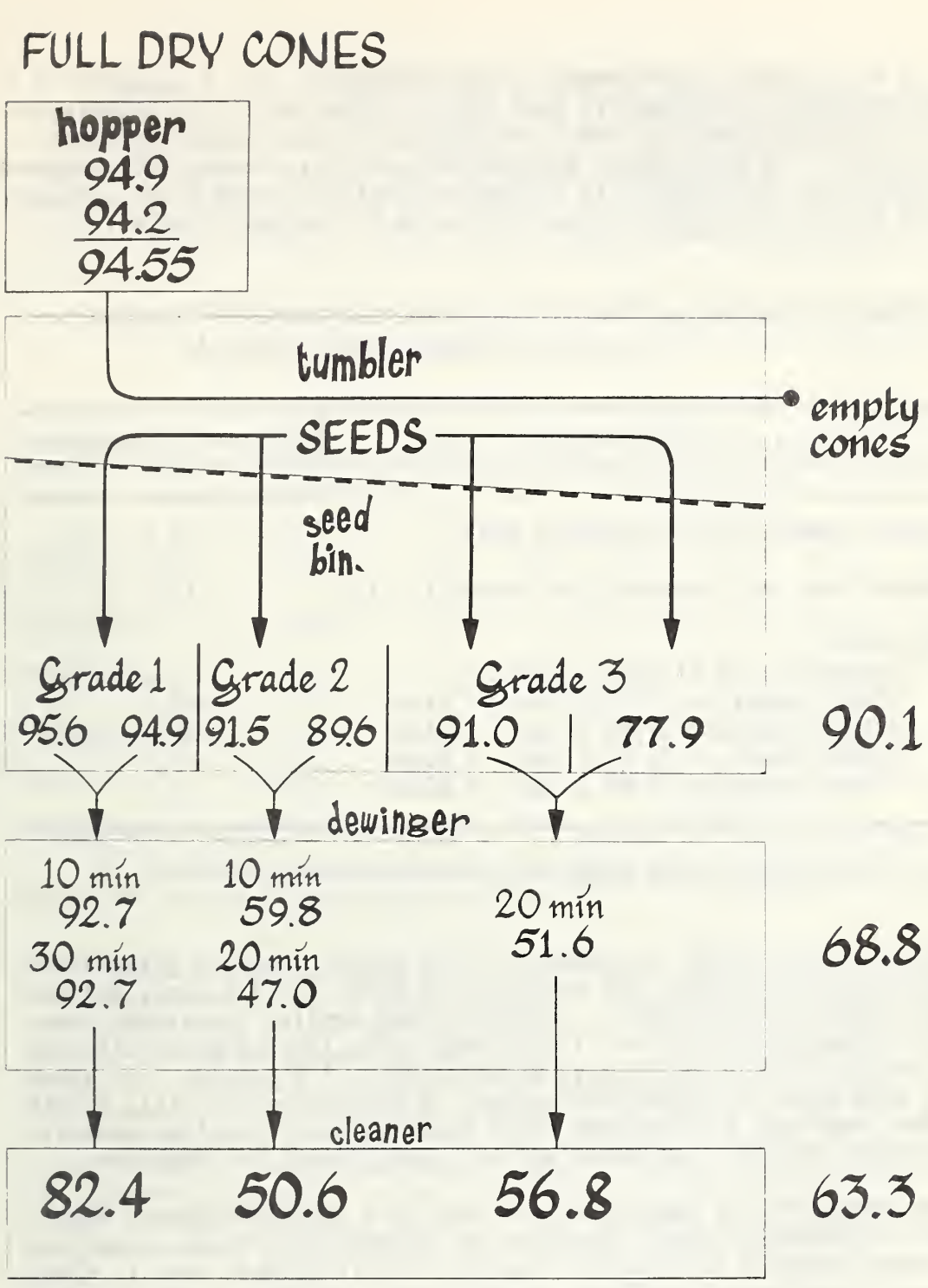

Figure 1.--Average germination capacity (percent) of Douglas-fir seed lot 5621 at three stages of processing. (Data from reference given in text footnote 2.)

In maltreatment experiments, Allen determined that a weight of 2.1 grams dropped on a Douglas-fir seed from a height of 16.5 centimeters--a 34.65 gram-centimeter (g.-cm.) force--was just sufficient to crack the seedcoat. If seeds whose germination capacity averaged 80.0 percent were subjected individually to a shock sufficient to crack the seedcoat, average germination capacity was reduced to 1.2 percent (table 1).

Table 1.--*Average germination capacity of stratified Douglas-fir seed after various maltreatments*[1/]

Treatment	Germination capacity
	----- *Percent* ------
Control--commercially processed seed	80.0
Cracked seed only--sorted from commercial lot	12.5
Sound seed:	
Cracked by 34.65 g.-cm. impact	1.2
Given impact of 23.10 g.-cm., 1 time	51.5
Given impact of 11.55 g.-cm., 1 time	81.2
Given impact of 11.55 g.-cm., 3 times	17.2
Given impact of 11.55 g.-cm., 5 times	7.2

[1/] Data from Allen 1958; see text footnote 2.

An impact of two-thirds this amount, 23.10 g.-cm., reduced germination capacity to 51.5 percent, but one-third as much, 11.55 g.-cm., had no adverse effect on germination. However, when applied repeatedly, the effect is cumulative: three 11.55 g.-cm. blows reduced germination to 17.2 percent; five blows reduced germination to 7.2 percent. In other words, seed which is bumped and squeezed in processing but still viable afterward may very well receive small bumps in later handling which prove fatal, though these bumps may be insignificant by themselves.

Dissemination by helicopter may give seed those additional small bumps. The metering device squeezes and crushes some seed, as can be seen when equipment is cleaned. Impacts, occurring when seed is slung out over a wide swath, may even exceed Allen's critical 34.65 g.-cm. force. Just falling on a rock, log, or stump without benefit of parachute provides considerable shock. Added to the damage caused by processing, any one of these events might be sufficient to kill an already weakened seed.

Recently, the Forest Service's Pacific Northwest Region conducted tests to determine to what degree helicopter seed dissemination devices were injurious to seed. In ground trials, replicate samples of four species were put through five helicopter disseminators and caught in suspended parachutes. On the average, germination was not reduced, but some inconsistencies in results are thought provoking (table 2).

Table 2.--*Average germination of endrin-treated seed before and after dissemination by five different helicopters*

Species	Before dissemination	After dissemination by helicopter					Average
		1	2	3	4	5	
	Percent[1/]						
Douglas-fir	53.0	53.5	65.5	45.0	58.0	54.0	55.2
White fir	20.0	21.0	17.0	16.0	21.0	20.0	19.0
Ponderosa pine	77.0	71.5	72.0	71.0	64.5	72.5	70.3
Lodgepole pine	85.0	87.0	90.0	90.0	85.0	90.5	88.5
All	58.9	58.2	61.1	55.5	57.1	59.2	58.2

1/ Difference between means must exceed 14.7 percent for significance at 5-percent probability level.

Only Douglas-fir germination was affected unequally by dissemination equipment on different helicopters. Germination was significantly lower after seed passed through equipment on helicopter 3 than after passing through equipment on helicopter 2. Though we can see that Douglas-fir germination percent after dissemination ranged from 45.0 to 65.5 percent, the 55.2-percent average is obviously not significantly different from the 53-percent average germination before dissemination. Surely, lack of statistical significance is unimportant here; if there is a choice, equipment which produced 65.5 percent germination will be used. The most important point is that the effect of dissemination equipment varied among helicopters. Why it varied has not been determined.

Seed Protection With Chemicals

Chemical coatings may harm seed germination in two ways: (1) they contain one or more ingredients which may be toxic to seed, and (2) they form layers on the seedcoat that may slow assimilation or be impermeable to the water and oxygen essential for germination. Partially weakened seeds, which would ordinarily produce seedlings, may not survive with such mechanical handicaps. Yet, coatings must be resistant to weathering and, therefore, be sparingly soluble in water to be effective.

Several treatments used for protecting seed from rodents have proven somewhat detrimental to germination. Dick et al.[3/] found that addition of Arasan 75 to a mixture containing endrin, Methocel-Rhoplex, and aluminum flake did not improve Douglas-fir seedling establishment and adversely affected seed viability in laboratory tests by 8 to 10 percent. Substitution of Dow Latex 512-R for Methocel-Rhoplex did not change results. Shea[4/] found that Arasan 75 decreased field germination of Douglas-fir and he recommended that use of Arasan 75 in the protective mixture be discontinued. Allen[5/] reported that Douglas-fir seed, stratified after treatment with tetramine, lost nearly 30 percent in germination capacity compared with untreated seed. Germination of shortleaf pine seed was adequate when treated after stratification with an endrin-anthraquinone-Latex 512-R mixture and stored at two temperatures for up to 30 days.[6/] Seidel found that this protective treatment reduced germination slightly but felt it was not enough to offset benefits of protection.

In the helicopter seed dissemination study, treatment with endrin reduced germination of Douglas-fir seed from 69 to 53 percent, white fir from 35 to 20 percent, ponderosa pine from 81 to 77 percent, and lodgepole pine from 88 to 85 percent. This finding was somewhat tenuous since the study was designed to test dissemination equipment, not endrin treatment, and there were no replicated tests made for comparing germination before and after treatment. However, consistently lower germination after treatment is a warning signal.

Another interesting point is that after dissemination, germination

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[3/] Dick, James, Finnis, J. M., Hunt, Lee O., and Kverno, Nelson B. Treatment of Douglas-fir seed to reduce loss to rodents. J. Forest. 56: 660-661, illus. 1958.

[4/] Shea, Keith R. Field survival of thiram-treated Douglas-fir seed. Weyerhaeuser Co. Forest. Res. Note 38, 8 pp. 1961.

[5/] See footnote 2.

[6/] Seidel, Kenneth W. Germination of treated shortleaf pine seed. U.S.D.A. Forest Serv. Res. Pap. CS-5, 12 pp., illus. 1963.

of treated Douglas-fir seed increased as much as 12.5 percent, from 53 to 65.5 (table 2). Individual replicates of other species also showed greater germination after dissemination than before. It is not clear whether this represents random variation or an equipment effect. Possibly, protective seedcoatings were cracked or worn off during dissemination, allowing easier penetration of oxygen and water.

We have also tested some candidate stickers, using calcium carbonate to substitute for the usual powdered ingredients. Most stickers tested, including some in use at present, did not adversely affect germination of seed from the two 1959 collections (fig. 2). However, there was one

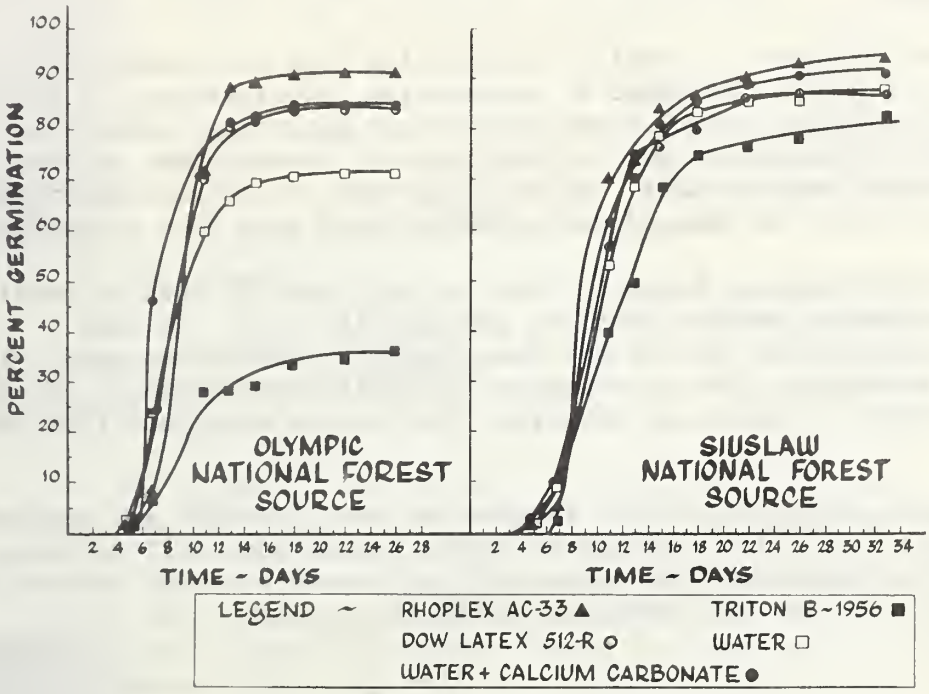

Figure 2.--Germination of Douglas-fir seed stratified for 3 weeks after sticker treatment.

potentially bad actor in the group--Triton B-1956 apparently hindered germination. An unnumbered Velsicol sticker, which did not adversely affect the 1959 seed, reduced germination of an older lot from 48 to 38 percent. This means that the effect of stickers may vary with age of the seed. Other stickers tested but not shown in figure 2 were Plyac, Gen-Flo Latex 671, Velsicol W617, and Velsicol WX888.

Though we now have good indications that several stickers may be safe when used on Douglas-fir seed, we do not know how they will act when mixed with various seed-protecting chemicals. Research on protective coatings for seed must be stepped up sooner or later.

The types of damage we have considered are obviously interrelated. First, the processing treatment bruises, squeezes, cracks, and breaks seedcoats and seeds. Chemicals are then added which may enter the cracks and breaks and make life harder for the damaged seeds. Some seeds, which survived despite cracks and breaks, may now succumb to the toxic chemical. The added coating may also restrict passage of vital water and oxygen. Next, the seed is disseminated by helicopter, being run through a grinder called a metering device and blasted forcibly down curved or angled chutes or tubes. Bumps and squeezes received here are added to those received in processing. Seeds, lucky enough to escape processing relatively unscathed, may receive fatal blows during dissemination.

The contribution to impaired germination from each source of damage is not known. It would be interesting, for instance, to know if chemical coatings affect seeds with intact seedcoats. Possibly, most impaired germination due to fungicides or rodenticides is visited upon seed with damaged coats. No comprehensive investigations of seed protectant effects on damaged and undamaged seed have been conducted.

We need effective chemicals that are <u>not</u> toxic to seed or people. We need processing methods that are gentler with seed. We need dissemination devices that do not bump, squeeze, and buffet seed. It may sound strange to hear a researcher imploring seed users to get more research done. It is not so strange. The impetus must come from the users.

As seed collection methods improve and seed orchards and production areas enjoy greater use, acreage of seeded forest land will increase. Seed used to regenerate these acres will be expensive seed. We must be prepared to make the best possible use of it.